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EXPLOSIVES SAFETY SEMINAR
HOUSTON, TEXAS

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AMMUNITION DISASSEMBLY

AND

EXPLOSIVE SECTIONING

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ABSTRACT

Remote control methods were developed to disassemble 40-mm ammunition. The projectiles were pulled from the cartridge cases, fuzes were removed from the projectiles, and explosive components were sectioned. Operations were performed remotely and monitored via closed circuit TV. The methods were improved upon to increase the efficiency of the teardown.

1.0 INTRODUCTION

A requirement to tear down HEI-PD and HE-PFPX rounds was safely accomplished through use of remote-operated equipment. The rounds were separated into their component parts of cartridge case, projectile and fuze. Sectioning of the projectile was performed on selected rounds. Component parts were then examined to determine the effects, if any, of the various conditions the rounds were subjected to previously.

Prior to the teardown, each round was x-rayed to verify safe position of the fuze. The projectile was then pulled from the cartridge case using a hydraulic pull cylinder. An air-operated impact wrench was used to unscrew the fuzes from the projectiles. Projectiles were sectioned as required with a band saw.

Once the method to accomplish each task was determined, the procedure was improved to increase efficiency. Thus, the disassembly and sectioning of the ammunition was conducted both safely and in a cost-effective manner.

2.0 SAFETY CONSIDERATIONS

In conducting the teardown of the ammunition, safety was considered uppermost. Nearly all operations were controlled from a remote location, or at some distance from the operations building, out of line-of-sight.

The main control building was located approximately 500 ft. from the operations building. Several dirt and gravel

barriers separated the two buildings. A third building was used for operating certain equipment. This third building was located 100 ft. from the operations building. A dirt barrier was in front of the operations building wall facing toward the other buildings and traffic. The site setup is shown in Figure 1.

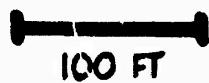
Two-way radios (Realistic Voice-actuated FM Transceivers) were used to maintain contact between operators in the various buildings. Since the HE-PFPX rounds had fuzes with electronic components, some concern was expressed over the safety of using radios in their vicinity and possibly setting off the fuze. After discussion with the fuze manufacturer, it was decided that it would be safe to use radios during the teardown of the HE-PFPX rounds. Closed circuit TV was used to monitor the operations at all times. The TV monitor was located in the control building.

Constant communication was maintained throughout each operation between the control operator and any operators at the other two buildings. No operation was performed without the verbal assent of all operators. The control operator constantly monitored each operation via closed circuit TV (CCTV). This operator also controlled the equipment which had switches located in that building.

LEGEND:

- ROAD
- BARRIER
- EQUIPMENT LINES

SCALE:



OPERATIONS
BUILDING

PULL FRAME
LATHE
SAW

HYDRAULIC PUMP
AIR COMPRESSOR

SECONDARY
CONTROL
BUILDING

CONTROL
BUILDING

TV MONITOR
LATHE SWITCH
SAW SWITCH

Figure 1. Site Layout.

A second (and, sometimes, third) field operator controlled some of the equipment and also switched rounds, recorded data and performed other tasks in the operations building.

3.0 X-RAYS

The first task in the teardown was to have the rounds x-rayed. The purpose for this was twofold. First, the x-rays were used to verify the safe position of the fuze prior to working with the round. Second, air voids in the explosive appearing in the x-ray could later be correlated to any voids found after sectioning of the projectile.

An outside vendor was chosen to do the x-ray field work. Preliminary x-rays of inert projectiles were taken to determine the best x-ray source and exposure time for the teardown requirements. Air voids could be seen most clearly from x-rays using gamma radiation with an iridium-192 source. Exposure time was approximately nine minutes with the source three feet from the film and rounds. X-ray radiation with shorter exposure times could have been used if safe fuze verification were the sole objective of the x-rays.

All of the HEI-PD fuzes and some of the HE-PFPX fuzes were previously marked as to the "0°-plane". X-rays

taken along this plane showed the S&A device in a position which revealed whether it was safe or not. Rounds with unmarked fuzes had x-rays taken along two planes, 90° apart. In this way, one x-ray or the other showed the S&A device clearly enough to determine if it was in the safe position.

Selected rounds had x-rays taken along additional planes. These were rounds that showed the possibility of having air voids in the explosive. The additional x-rays would later be used to determine where the projectiles would be sectioned.

The HE-PFPX rounds have a tungsten-ball sleeve around part of the projectile. This sleeve had to be removed prior to additional x-rays being taken so that any air voids could be seen.

4.0 BULLET PULL

The next task in the teardown was to pull the projectile from the cartridge case. The propellant from the case was then weighed and the projectile de-fuzed.

An Enerpac Model RCP-55 5-ton hydraulic pull cylinder was used to pull the projectiles from the cases. The maximum force actually needed was 7100 pounds-force. Most rounds required only 4500-5500 pounds-force.

One end of the pull cylinder was attached to a

heavy metal framework so that the cylinder hung vertically. A fixture, especially designed to fit the projectiles, was attached to the free end of the cylinder. This fixture clamped around the projectile and held on to the projectile by means of a small lip around the projectile. (See Figures 2 & 3).

The base (primer end) of the cartridge case slid into the bottom fixture. This fixture was welded in place on the framework at the necessary distance from the projectile fixture. The lineup of the assembly was checked for vertical straightness. If not straight, the projectile would be pulled with a sidewise jerk, possibly spilling propellant from the case.

The pull cylinder was operated from a remotely-located hydraulic pump. A closed circuit TV monitor, located in the control building, was used to monitor the operation. Two-way radios were used to provide communication between the two areas.

The first step in pulling the projectiles was to secure the round in the pull fixtures. Once in place, the building and area were cleared of all personnel. The field operator was positioned at the hydraulic pump and a control operator monitored the CCTV.

After confirming via radio that the pull was ready

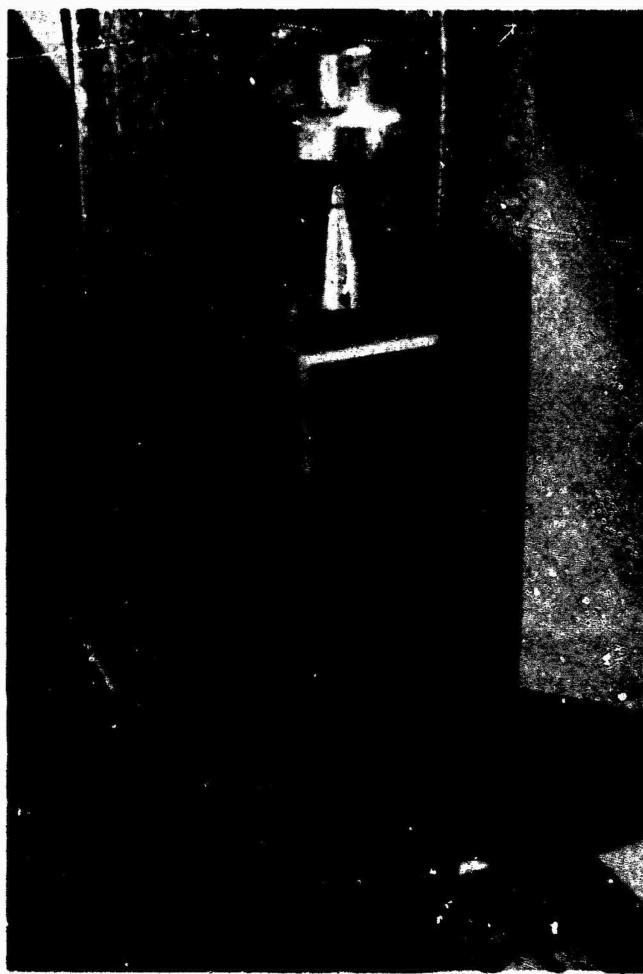


Figure 2. HE-PFPX round in place
for bullet pull.



Figure 3. Close-up of HE-PFPX projectile in upper pull fixture.

to start, the field operator started the pump. The control operator then indicated when the projectile was free of the case. The field operator waited 30 sec. for an "all clear" from the control operator before entering the operations area. Any initiation of the propellant would become evident within 30 seconds after the pull. The field operator then entered the operations building to remove the separated components and load up another round. The propellant was weighed by either the field operator, or a third operator.

Once set up, the projectiles could be pulled at a rate of 20-25 per hour, with three operators working. Slow-downs occurred when the projectile fixture slipped during the pull. The fixture was then re-tightened and the pull tried again. Slippage usually occurred only with those rounds requiring higher pull forces, around 7000 pounds-force.

After being separated, the projectiles were placed in Velostat bags and stored in a small magazine until the fuze removal operation began. The propellant, after being weighed, was stored in a drum for later disposal. Cartridge cases were put back in the original shipping container and stored for later de-priming.

5.0 FUZE REMOVAL

After the bullet pull, the fuzes were removed from the projectile. The requirement was that the fuze be removed undamaged and shipped back to the vendor.

Several methods were considered for removing the fuze. It was initially thought that too much force would be required to unscrew the fuze from the projectile. Therefore, ways to cut the fuze off were examined first. Since these proved to be difficult, a means to unscrew the fuze was finally studied.

The HE-PFPX fuzes had two set screw holes which allowed a fixture to be attached to the fuze. The fixture allowed for easy removal of the fuze by turning it off. The HEI-PD fuze had no set screw holes for attaching a fixture. After some experimenting, a fixture with four pointed set screws was developed. The screws in the fixture could be tightened enough to grip the fuze and permit turning. The small indentations produced by the set screws were not considered damaging to the fuze.

Another fixture was designed to grip the projectile. Set screws in the fixture held the projectile by the brass rotating band. The projectile fixture could then be chucked into a lathe.

Initial attempts at using a lathe as a means of

turning off the fuze, showed the lathe to lack the torque necessary to break the seal on the fuze threads. Either another, more powerful lathe, or another means of turning, would have to be tried.

An area of concern in unscrewing the fuzes was the possibility of setting off the fuze by rotating it too fast. The procedure at first called for turning the projectile while holding the fuze still. This procedure could be used with a lathe capable of providing the required torque. After some consideration, it was decided that rotating the fuze at low rpm's (1000, or so) while holding the projectile still would be safe.

The method finally used to remove most of the fuzes was to use an air-actuated impact wrench. The projectile was secured in the lathe and the fuze fixture was attached to the impact wrench. The wrench was clamped in place on the lathe frame. A remote-located air compressor was used to run the wrench through means of a valve.

The field operator secured the projectile and fuze into the fixture/lathe assembly. (See Figure 4). Upon clearing the area, and a go ahead from the control operator via radio, the field operator would open the air valve to turn on the wrench. The control operator monitored the operation via CCTV and radioed to the field operator when the fuze was removed and air to the wrench could be shut off.

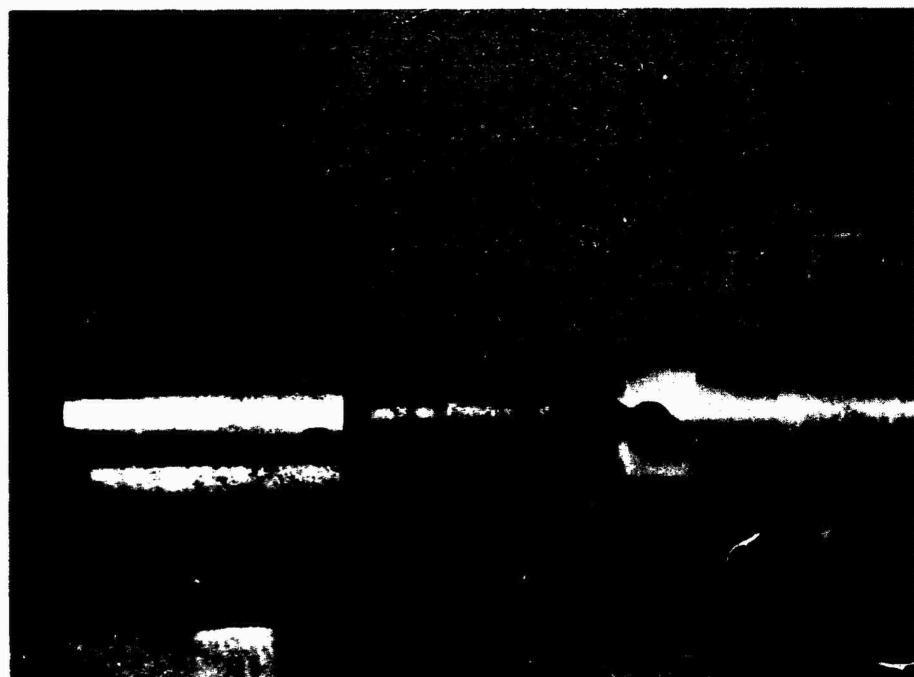


Figure 4. HE-PFPX projectile
in fixtures for
fuze removal.

After a wait of one minute to verify that the removal of the fuze didn't result in an initiation, the field operator then entered the operations building and removed the fuze and projectile from the assembly. The process was repeated for the next projectile.

Due to exudation of the explosive (as a result of high temperature conditioning), some HEI-PD fuzes wouldn't come free of the projectile even though they were unscrewed. Examination of the x-rays revealed exudation into the area around the booster which prevented easy removal of the fuze. An adaption of the bullet pull assembly was then used to remotely pull the fuze free of the projectile. In a few cases, the booster cup remained stuck in the projectile.

With certain of the HE-PFPX rounds, it was possible to safely remove the fuze by hand. These rounds were ones that had not undergone any temperature conditioning, and therefore, wouldn't have exudation in the fuze threads. A fixture was attached to the fuze which was then unscrewed manually.

6.0 SLEEVE REMOVAL

The HE-PFPX projectiles had a tungsten ball sleeve around two-thirds the length of the projectile body. This sleeve was removed from selected projectiles in order to allow a clear x-ray to be taken of the explosive and also to

facilitate any sectioning.

A lathe was used to machine off the outer steel layer. Once this layer was removed, the tungsten ball sleeve was easily cut off. Initial attempts at cutting the outer sleeve off with a band saw were not successful. A mill could possibly have been used, but proved to be a too costly investment for this task.

A dummy fuze was screwed in the projectile which was then secured in the same projectile fixture in the lathe used to remove the fuzes. The lathe was then set to cut 0.005" to 0.015" off of the projectile. After setting up the lathe and starting the coolant, the field operator then cleared the area.

The controls for the lathe were located in the control building. The control operator, after receiving the go ahead from the field operator, started the lathe. The operation was monitored via CCTV and the operator switched off the lathe when the cutting tool reached the rotating band of the projectile.

The field operator, after waiting 30 seconds to make sure no problems developed, then entered the operations building. The lathe was readjusted to cut more of the sleeve off, and the operation continued until the entire metal part of the sleeve was removed. The field operator then used a

knife to carefully cut the plastic between the tungsten balls and removed the entire sleeve. The projectile was then ready for further x-rays and/or sectioning.

7.0 SECTIONING

Certain projectiles were sectioned in order to expose the explosive inside and to reveal air voids detected in the x-rays. Some of the HEI-PD projectiles were sectioned at the booster cavity end in order to better see any exudation that may have occurred.

While it was easily decided to use a saw to cut the projectiles, the type of saw to be used required some consideration. First of all, the projectile cases were made of hardened steel (RC 40 to 45) which would be difficult to cut. Second, spark and excessive heat generation in the cutting process had to be non-existent due to the explosives in the projectile.

The first requirement suggested use of an abrasive saw. This choice was eliminated because of the sparking produced during cutting. Attempts to eliminate the sparking by cutting under water were unsuccessful. Also, the saws examined could not accommodate the projectile or were too expensive.

The next, and final choice, was a band saw. Both vertical and horizontal band saws were examined. Due to the possibility of having to make cuts in the projectile

lengthwise, it was decided that a vertical saw would work best. The saw would have to be able to be remotely controlled and have some sort of automatic feed. A small, vertical band saw was chosen and a gravity feed system was built to use with it. A remote control switch was installed in the control building.

The gravity feed system was designed to be simple and easily adaptable. The feed tray itself could hold either HEI-PD or HE-PFPX projectiles in a number of positions. (See Figure 5). A hanging weight attached to one end of the tray provided the gravity feed. Different weights could then be used to vary the feed rate. A channel along one side of the saw table guided the feed tray in a straight line.

Bandsaw blades with an M42 edge were used to cut through the hardened steel projectile cases. A wide, but smooth, cut was produced with these blades. The cooling system used a synthetic, biodegradable coolant in water. The coolant was not recycled due to possible presence of explosive particles in the coolant.

From the x-rays, the plane of each cut was determined and then marked on the projectile. The projectile was placed in the feed tray in the desired position. In order to keep the projectile from rolling or moving in the tray, acrylic

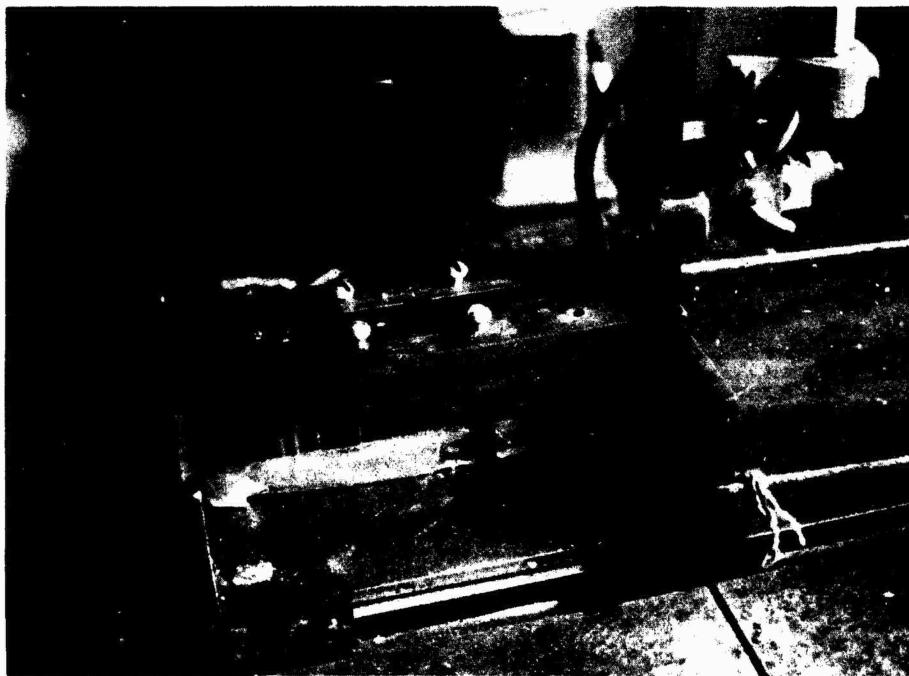


Figure 5. HEI-PD projectile positioned in feed tray for longitudinal cut.

pieces were formed to support the projectile. The set screws in the tray were tightened and alignment was checked.

Sectioning began with the field operator starting the cooling system. After clearing the area, the field operator informed the control operator that everything was ready to start. The control operator then started the saw and monitored the cutting. At any sign of a hang-up, or if the coolant stopped, the saw would be switched off. The field operator then waited one minute before entering the operations building.

A full longitudinal cut took approximately one hour and other cuts proportionally less. The saw speed was 55 ft./min. and the gravity feed weight varied with the projectile being cut. A 10 lb. weight was used most of the time while a lighter weight was needed to cut the thinner walls of de-sleeved HE-PFPX projectiles. Too large of a weight often caused the feed tray to jerk or the blade to jam. Too light of a weight would either take a long time to cut or wouldn't pull the tray at all.

Samples of the projectiles cut can be seen in Figures 6 through 9. Figure 6 shows a longitudinal cut of a HEI-PD projectile. Radial cuts of HEI-PD and HE-PFPX projectiles can be seen in Figures 7 and 8, respectively. The



Figure 6. HEI-PD projectile
cut longitudinally.



Figure 7. HEI-PD projectile cut
radially into three pieces.
Air voids in the explosive
can be seen in upper and
lower left pieces.



Figure 8. HE-PFPX projectile cut
radially into two pieces.
Small air void in explosive
is circled.

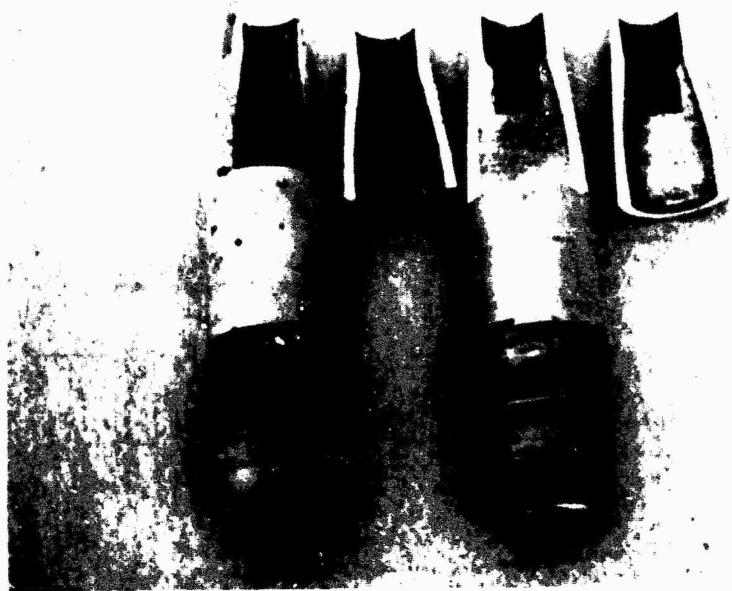


Figure 9. HEI-PD projectiles cut to reveal booster cavity. Projectile on left was subjected to high temperature conditioning.

cuts were smooth enough to allow a clear view of some air voids in the explosive. The jagged cut seen in Figure 8 was the result of using too heavy a gravity feed weight during cutting. The blade jammed and the projectile had to be rotated to finish the cut. The cuts shown in Figure 9 were done to reveal the booster cavity more clearly. The HEI-PD projectile on the left had been conditioned at a high temperature and the cut shows the exudation around the booster cavity. The HEI-PD projectile on the right shows non-exudating explosive.

8.0 CONCLUSIONS

The procedures developed to disassemble and section the ammunition proved to be safe as well as efficient. The teardown of over 240 HEI-PD and HE-PFPX rounds was safely accomplished.

The objectives of the teardown were also successfully met. The methods used for each task allowed the results of conditioning the rounds to be easily examined. X-rays and sectioning revealed the air voids and exudation that were of concern.

The efficiency of each operation was improved as the work proceeded. Safety was continually emphasized throughout the teardown, with the result that the rounds were disassembled and sectioned in a safe and efficient manner.